

Manuscript Number: JPAIN-D-09-00088R1

Title: Perceiving pain in others: Automatic and controlled mechanisms

Article Type: Focus Article

Keywords: assessment; automatic; expression; empathy; reflexes; self-report; credibility

Corresponding Author: Dr. Kenneth Denton Craig, PhD

Corresponding Author's Institution: University of British Columbia

First Author: Kenneth D Craig, PhD

Order of Authors: Kenneth D Craig, PhD; Judith Versloot, PhD; Liesbet Goubert, PhD; Tine Vervoort, PhD; Geert Crombez, PhD

Abstract: Recent developments in clinical, cognitive and behavioural sciences as well as in social neuroscience can provide new perspectives on our understanding of different forms of pain expression and the social reactions of observers to various types of pain expression. Studies indicate that pain expression is governed by both automatic (unintentional, reflexive) and controlled (intentional, purposive) neuroregulatory systems. Reciprocal mechanisms in observers responsible for automatic (unintentional, reflexive) and controlled (intentional, reflective) reactions also appear important. Observers appear more likely to display immediate "visceral", emotional reactions to unintentional, reflexive expression, whereas controlled expression characterized by purposive behaviour appears more likely to elicit reflection on the nature and origins of the person's pain. This review summarizes research within the context of a theoretical model for understanding how pain is perceived in others. **Perspective:** People attempting to understand another person's pain may have access to the person's spontaneous behavioural reaction as well as verbal report and other purposive communications. The former instigates reflexive and emotional reactions whereas the latter tends to be perceived as confounding expression of experience with response to situational demands.

Focus Article

Perceiving Pain in Others: Automatic and Controlled Mechanisms

Kenneth D. Craig^a, Judith Versloot^a, Liesbet Goubert^b, Tine Vervoort^b, and Geert Crombez^b

^aUniversity of British Columbia

^bGhent University

Note: Corresponding author for this manuscript is Dr. Kenneth D. Craig, 2136 West Mall,
Vancouver, B.C., Canada V6T 1Z4. Tel.: 604 822 3948; Fax: 604 822 6923; email:
kcraig@psych.ubc.ca

Author Information:

Kenneth D. Craig, PhD

2136 West Mall

Department of Psychology

University of British Columbia

Vancouver, B.C.

Canada V6T 1Z4

Judith Versloot, PhD

2136 West Mall

Department of Psychology

University of British Columbia

Vancouver, B.C.

Canada V6T 1Z4

jversloot@psych.ubc.ca

Liesbet Goubert, PhD

Department of Experimental-Clinical and

Health Psychology

Ghent University

Henri Dunantlaan 2,

9000 Gent, Belgium

Liesbet.Goubert@UGent.be

Tine Vervoort, PhD

Department of Experimental-Clinical and

Health Psychology

Ghent University

Henri Dunantlaan 2,

9000 Gent, Belgium

Tine.Vervoort@UGent.be

Geert Crombez

Department of Experimental-Clinical and

Health Psychology

Ghent University

Henri Dunantlaan 2,

9000 Gent, Belgium

Geert.Crombez@ugent.be

Running title: Perceiving others' pain

Key words: assessment, expression, empathy, reflexes, self-report, credibility

Abstract

Recent developments in clinical, cognitive and behavioural sciences as well as in social neuroscience can provide new perspectives on our understanding of different forms of pain expression and the social reactions of observers to various types of pain expression. Studies indicate that pain expression is governed by both automatic (unintentional, reflexive) and controlled (intentional, purposive) neuroregulatory systems. Reciprocal mechanisms in observers responsible for automatic (unintentional, reflexive) and controlled (intentional, reflective) reactions also appear important. Observers appear more likely to display immediate “visceral”, emotional reactions to unintentional, reflexive expression, whereas controlled expression characterized by purposive behaviour appears more likely to elicit reflection on the nature and origins of the person’s pain. This review summarizes research within the context of a theoretical model for understanding how pain is perceived in others.

Perspective: People attempting to understand another person’s pain may have access to the person’s spontaneous behavioural reaction as well as verbal report and other purposive communications. The former instigates reflexive and emotional reactions whereas the latter tends to be perceived as confounding expression of experience with response to situational demands.

Perceiving Pain in Others: Automatic and Controlled Mechanisms

Recognizing and interpreting the significance of pain expression in others can be of great importance to the suffering person and the person witnessing the other's distress. Various actions, including language, paralinguistic vocalizations, facial expression, body posture, and escape or avoidance behaviour, may signal pain to others. These events can command the attention of observers from perspectives of both self-interest and social beneficence (and sometimes malevolence). They permit recognition of potential danger and provide opportunity for harm avoidance at the same time as they allow appreciation of what is happening to the person in pain, perhaps leading to provision of care^{45, 41, 92}. The adaptive value of responding to pain in others is embedded in the evolutionary history of humans and ancestral species^{7, 27, 30, 87, 90}. Despite its importance, the study of the social transaction initiated by pain expression is not well developed^{80, 82, 91} although it is fundamental for understanding pain assessment in research and clinical practice⁸³.

Recent developments in clinical, cognitive and behavioural sciences as well as in social neuroscience can provide new perspectives on our understanding of different forms of pain expression and the social reactions of observers. Studies indicate that pain expression is governed by both automatic (unintentional, reflexive) and controlled (intentional, purposive) neuroregulatory systems⁴³. Reciprocal mechanisms in observers responsible for automatic (unintentional, reflexive) and controlled (intentional, reflective) reactions also appear important. This review summarizes research within a theoretical model of how pain is perceived in others.

The Background

Tapping into the pain experience of another through use of painful expression is a challenging task. Expression can only partially represent the complexity of the subjective experience; hence, they are not equivalent^{26, 43, 55, 56, 86}. At the neurobiological level of analysis, different systems are associated with pain experience and expression. Studies of sensory and affective features of pain experience have

focused upon afferent nociceptive and neuropathic mechanisms and central processing¹⁵, whereas investigations of pain expression necessitate examination of systems responsible for language and efferent neuromotor regulatory mechanisms^{80,88}.

Operationalizing the distinction between pain experience and expression poses problems. From the research perspective, experience cannot be studied through other than some form of expression. Inevitably, understanding the pain experience of another requires inference. One can identify various cues to be important for observer judgments in the behaviour of the person in pain (self-report, other features of vocalizations, facial activity, body activity, limb withdrawal, writhing, and other nonverbal behaviors). Other evidence such as the presence of precipitants of injury^{50,61}, actual bodily injury, and physiological response to tissue stress or pathology⁵ can also influence judgements. However, the presence and experience of pain are often poorly related to the nature and magnitude of tissue stress or damage¹¹. The inferences and judgments of observers necessitate attention to the behavioural reactions of the person in pain.

The primary resources available for examining the subjective experience of pain are self-report and nonverbal expression, categories of pain response that are readily differentiated and usually identified as conceptually different. In tightly controlled studies, they can be highly correlated⁵⁵; more typically they are only modestly correlated, with contextual factors determining the magnitude of the relationship^{56, 70}.

In competent, well-motivated people, *self-report* can provide a valid estimate of pain. But the need for competence in cognitive functioning and the potential for biased responses reflecting sufferer expectations and needs cannot be ignored^{51, 78}. The individual's perception of optimal performance and outcome in a given setting appears crucial and determines self-presentation. Those *assessing* the person for pain also may bias self-report by providing cues as to what level of report is expected or appropriate. Thus, self-report must be recognized as representing some combination of expression of personal experience and a response to an appraisal of the immediate situation.

Nonverbal expression typically is endorsed as important when infants, young children, seniors with dementia, or others with communication limitations are unable to provide self-report^{17, 46}. However, nonverbal assessment is also important in everyday and clinical social discourse. Nonverbal expression typically adds context and meaning to language and can be perceived as more credible than self-report because it is not as subject to conscious control as the use of language⁶⁷. But similar to self-report, nonverbal expression is not exclusively reflexive. It also confounds subjective experience and situational demands. Nonverbal expression is sensitive to audiences^{54, 69, 81, 85}. People also can be reasonably successful in suppressing or exaggerating nonverbal pain expression^{26, 48, 44, 58}, in accordance with perception of situational demands, thereby again confounding spontaneous with socially predicated expression. It is not surprising that observers, clinicians or otherwise, experience difficulties in determining whether either self-report or nonverbal behaviour represent manifestations of pain experience or reactions to self-serving or situational demand biases.

We propose an alternative classification that distinguishes between automatic, reflexive features of the response to pain, perhaps best illustrated by the protective nociceptive flexion reflex^{36, 9}, and expressions of pain that reflect higher levels of central processing or purposive, deliberative control. Automatic reactions, whether in response to pain or other life events, tend to be sufficiently transparent so as to signify their direct meaning, and include “screaming in pain, laughing with joy, and growling with anger”⁶⁰, (p. 29). Controlled, intentional expression is typified by the use of language for self-report purposes but also would include integrated sequences of instrumental motor activity^{43, 56}. The distinction is important because observers are disposed to attributing causes to other persons’ actions^{47, 59}. Reflexive activity is considered to have quite different functional implications than activities that are suggestive of deliberate intention and executive control. Complexity is added by the reality that although pain behaviour may be unintentional (e.g., facial expression, or even nociceptive pain reflexes),

it can be controllable to a certain extent (e.g., inhibiting facial expression, exaggerating withdrawal reactions, etc.)^{52, 68, 71}.

The distinction between systems that are automatic, on the one hand, or subject to processing and control, on the other, also characterizes observer reactions. Witnessing others reacting to acute painful events is capable of instigating immediate “visceral” or gut level emotional experiences¹⁶. The rapidly unfolding social neuroscience literature on cerebral correlates of witnessing others in painful distress documents the brain states to be observed^{50, 63, 73}. These automatic, uncontrollable reactions are accompanied by immediate attention and parallel controlled reflective appraisal of the nature of the other person’s situation, as well as attention to likely sources of the activity observed, as the observer seeks to understand what is happening to the other person.

The theoretical distinction between two major observable behavioural sources of information concerning another person’s pain experience and two major patterns of reacting to others in pain arises from theoretical and empirically derived models of information processing implicating at the extremes automatic and controlled mechanisms, with these interrelated and operative in varying degrees^{62, 34}. The proposition that human performance results from an interplay between automatic and controlled processing of information⁷² is predicated upon the understanding that in complex environments attention must be guided to process critical stimuli, yet other routine, well rehearsed and overlearned activities are executed repetitively without demands on attention. It has been applied to understanding social interaction phenomena in other contexts^{77, 3} including study of such phenomena as automatic stereotype activation^{2, 12}.

The following elaborates on this distinction as it contributes to understanding how those experiencing pain react and how observers respond to different forms of pain display.

Automatic and Controlled Features of the Behaviour of the Person in Pain

Systematic differences in the categories of painful expression set the occasion for variation in how observers perceive and respond to the person in pain.

Unintentional expressions of painful experience. Automatic pain manifestations are involuntary, spontaneous, triggered, stereotyped, predisposed sets of behavioural reactions elicited by noxious stimuli. They accompany but do not wholly or exclusively represent the sensory, affective and cognitive features of pain. From a physiological perspective, they are the somatomotor features of the coordinated central, hormonal, and autonomic response to tissue insult that have the relatively distinctive character of preparing the person to defend against tissue damage.

In considering types of automatic behaviour it is useful to distinguish between observable actions that are directly protective, because they permit escape or avoidance of sources of pain, and those that are indirectly protective because they communicate distress to others, thereby eliciting their protective interventions⁸⁰. The former are represented by withdrawal reflexes and assuming guarded postures⁵³. They act largely outside conscious awareness and deliberation. Communicative actions can also be reflexive or automatic. Infant behavioural reactions to painful events are reasonably seen as evolved protective behaviour, with control only emerging later on in infancy^{23, 42, 60}. During the earliest moments and months of life, some of the protective behaviour is primarily in the form of social communication, for example, crying or facial expression, thereby informing parents and other adults potentially able to intervene with sources of distress and/or danger⁴².

Many communicative and other protective actions are reasonably construed as biologically prepared and unlearned. In older children and adults, continuity and stereotypy in various manifestations of pain can be observed²³. Features of facial expression, paralinguistic qualities of speech, guarded behaviour and protective posture would appear to satisfy criteria for unintentional signs of pain, i.e., they are reflexive, display striking structural and functional consistency across the life span, the person largely is not aware of them, but they can be controlled to a certain extent. Criteria for automatic actions, as defined by Moors & De Houwer⁶² include processing at a relatively non-conscious

level, efficiency in terms of not requiring effortful processing, absence of a formulated goal, and being purely stimulus driven. Concerning observable actions relevant to social communication, facial expression is typically the most salient and instructive for the observer^{24, 70, 90}. A relatively stereotyped facial display of pain has been identified that is distinguishable from non-noxious emotional states, both behaviourally, in the judgments of others⁷⁴ and in observer brain states documented through neuro-imaging⁷³, but other socially relevant actions may be identifiable, for example, cry and paralinguistic qualities of speech.

Automatic responses are expected to be relatively stimulus driven and independent of attention and contextual influence⁶². However, it is clear that emotional and cognitive factors may modify reflexive responses, for example, stress induced analgesia is capable of diminishing reflexive withdrawal responses in rats and humans³⁵ and negative emotions can potentiate startle in humans⁶. While facial expression is a candidate for relatively immediate responding without conscious attending to the display, it is context-sensitive and linked to environmental demands. For example, presence of an audience of strangers tends to inhibit facial expression of pain⁵⁴, although children who engage in high levels of catastrophizing appear to indiscriminately display pain and are less likely to suppress pain expression⁸⁶. Furthermore, automatic responses are to some extent subject to voluntary control, for example, suppression⁷¹ or enhancement⁴⁸. As children mature, originally automatic manifestations of pain come at least partially under voluntary control. For example, the essentially reflexive crying of the neonate becomes more of a speech act²⁵ and children learn to suppress pain expression in the presence of peers when negative reactions are anticipated⁵⁸. Control can be achieved over facial displays of pain²², including both exaggeration and suppression of the display; however, the exaggerated display differs from the genuine display in subtle ways⁴⁹, and neither faking nor suppression of facial displays are wholly successful^{44, 67}.

Intentional expressions of painful experience. These can be construed as typically deliberate, conscious, and coordinated by executive functions¹. The latter are implicated when complex cognitive

sub-processes such as planning, anticipation, and decision-making become engaged. The use of language appears to best illustrate controlled expression of pain. It is noteworthy that complex, coordinated or innovative responses to situational demands can come to be relatively automatic, in this instance enacted without deliberation, when thoroughly well rehearsed in particular situations^{3, 62}.

Understanding controlled expression would appear to be more important to understanding human pain expression, although continuity in controlled expression across primate species is evident²⁷.

Interaction between automatic reactions and controlled expressions would be expected, with the latter coming to modulate the former in the course of human ontogeny, but there are limits to the extent that automatic expressions can be over-ridden by conscious control.

Automatic and Controlled Features of Perceiving Pain in Others

Cues related to pain in another person have the potential to influence observer perception of pain, some as a result of automatic activation, with others acquiring meaning only through conscious deliberation and executive processing. The act of perceiving others in pain has been characterized in a theoretical model of pain empathy as the product of both bottom-up and top-down variables^{38, 39}.

“Bottom-up” information is derived through perception of the actions of the person manifesting pain.

The concept refers primarily to automatic reactions to the painful reactions of others and would implicate the detection of pain. This is appraised and achieves significance for the observer through utilization of “top-down” information reflecting application of the beliefs, expectancies, attitudes and biases of the observer, a process characterized by greater levels of controlled processing..

Automatic Reactions. These are characterized as reflexive, intuitive, automatic “gut feelings” evoked by the pain reactions of others. These “visceral” reactions are reasonably construed as more ancient in their evolutionary origins, conserved across phyla by virtue of their functional advantages in warning, motivating and protecting progenitors, thereby increasing reproductive fitness. There would appear to be automatic processing of cues through biologically prepared innate, unconditioned feature detectors that give rise to reflex-like responses. Current brain imaging studies of biological reactivity

demonstrate a powerful and immediate biological impact of the experience of witnessing others in pain on observers^{8, 28, 50, 63, 73, 76}.

Reactions are influenced by contextual factors (e.g., setting and social cues, and characteristics of the person in pain^{19, 29, 40, 57}). The relationship between the observer and the person in pain can dictate the reaction and perhaps commitment to the person in pain. This is evident in both behavioural and brain imaging studies. For example, judgements of pain in infants differ systematically across parents, nurses and pediatricians⁶⁵ and the perceived fairness of others expressing pain were found to modulate empathic neural responses⁷⁵.

Automatic reaction patterns would not be restricted to reflexive or autonomic activation, but could include automatic instigation of thoughts, beliefs and biases. Inherent sensitivity would appear to involve matching of stimulus input to prepared schema, thereby instigating unconditioned and coordinated reaction patterns. In turn these reactions would be amenable to conditioning and yield templates that guide automatic evaluation of perceived threat and reactions thereafter^{4, 10, 64, 84}.

Controlled processing. When an observer attends to another person's plight, automatic reactions would be accompanied by efforts to understand and plan actions suitable to the situation⁷⁷. There is a need to know not only what is happening to the individual but also why this is happening, what sequence of events led to the person's painful distress, and what the person could do, or what the observer could do to resolve the situation. Problem-solving, memory, judgment, attitudes and biases are likely to be implicated. This higher level of neuroregulatory information processing would implicate executive functions^{52, 79}. Automatic processing is reasonably effortless or passive, with controlled processing more likely to predominate when conflicting or disconfirming evidence is present and active deliberation is necessary to resolve contradicting information and demands⁷⁷. Both unconscious processing and consciously guided conceptual-level processes would come into play, allowing observer knowledge to refine judgements about the nature of the other's distress. Thus, elements of automatic processing are implicated in controlled reactions. There would be consideration of risks and appraisal of

strategies for harm avoidance for oneself and the person in pain^{92, 41}. Beliefs (true and false), expectations, or prior knowledge would have an impact, as would the capacity for self-regulation of emotions, and empathy. Reasoned appraisal should lead to a broad understanding of the other's experience, its origins and likely outcomes. While one can distinguish between bottom up and top down processes, they operate in parallel, with conscious processing persisting longer than the immediate spontaneous reaction³⁸.

Interactions between controlled and automatic processing in sufferers and observers

Observer reactions appear to vary systematically with the different categories of pain expression in the person being observed (see Figure 1 for a schematic representation of the interaction). Expression of pain indicative of automatic reactions to situations (reflexes, emotional reactions) instigates different reactions in observers than controlled reactions indicative of planned, goal-directed behavior. Thus, different manifestations of pain would not be equivalent to others in their capacity to instigate particular reaction patterns.

Observer reactions to automatic expression. These stimulus driven reactions would be intuitive and immediate. The observer need only be passive, but the impact appears potent. Facial displays depicting vivid emotional expression have been found to be particularly effective in commanding attention and to be prepotent in their impact³⁷. Little cognitive participation in the emotional reaction would be expected, although efforts to understand what is happening would also be immediately instigated (controlled reactions). In the primordial world, through to the present, observing these reactions in others would instigate a sense of personal danger with fear for the other person a subordinate response^{45,73,92}.

It is noteworthy that the cues most likely to instigate emotional processing fall in the domains of raw visual or auditory experience. These sensory modalities are also basic to reading and speech but these human capabilities rely extensively upon more complex, learned cognitive skills. Linguistic and literacy skills come to be acquired slowly during development of the child, signalling the complexity of

the cognitive processes engaged when language or written communications are used to convey information about painful states. The semantic features of self reports rely upon symbolic/linguistic mediation, or top down processing. However, paralinguistic qualities of speech convey the emotional or mood status of the speaker and some forms of language (e.g., swear words, particularly evocative language used by authors or patients, or poetry) are capable of instigating immediate, vigorous visceral reactions⁶⁶. Language also has a capacity to automatically instigate certain automatic appraisals of events from memory when objects of attitudes are encountered, for example, prejudices^{32, 33}.

Observer reactions to intentional expression. While also immediate, these observer reactions would be of longer duration, as decoding and appraisal of information would require complex and effortful⁶² cognitive processing. This would require attentional and problem solving resources, as effort was expended to sort out competing interpretations. The subtle nuances of language are important in differential diagnosis as alternative explanations of signs and symptoms are explored. In everyday social experience, when pain complaints are made, there must be similar searches among competing explanations of the origins of the individual's complaints. Listeners are likely to appreciate that the account is determined by both internal states being described and the speaker's appraisal of the situation.

The suffering person's capacity to control expression would make the expression more difficult to understand, more ambiguous as to its origins, and less readily interpreted as the immediate product of specific stimuli. It seems less likely that controlled reactions alone would be capable of triggering the same full empathic emotional reactions provoked by automatic bottom up stimuli, although, as discussed above, skilled narrators or writers seem capable of generating verbal scenarios capable of provoking resonant reactions in others. Patients often work hard to present convincing cases of the gravity of their condition⁸⁹. Given awareness of the potential for voluntary control, risks of fabrication may be appraised.

People presenting with pain invariably are subject to careful appraisal by others^{18, 82}. While trust seems the accepted norm and clinicians are routinely enjoined to believe patient self-report of pain,

optimal care giving and prudent stewardship of resources require judgements about the legitimacy of the representations of the person in distress. Medically unexplained pain appears particularly susceptible to doubts about the credibility of complaints. Patients for whom there is no scientific explanation of their pain are described as at risk of being marginalized from meaningful professional care and treatment¹⁴. In the absence of medical evidence for tissue damage or stress, examiners must rely upon symptom complaints; hence, credibility is likely to be questioned. Universal propensities to detect cheaters have been postulated by evolutionary biologists to account for careful scrutiny of others in social transactions^{13,20,48,49,90}. Prkachin, Solomon and Ross⁷⁰ observed that suspicions surrounding the motivations of the patient impacted pain judgments during clinical decision making. Enjoining health care practitioners to utilize and believe self-report to some extent appears to be founded upon implicit recognition of the limited effectiveness of self-report in generating resonant feelings in observers.

Conclusions

Understanding the process whereby observers infer the presence and nature of pain in others requires an appreciation of the interaction between the expressive behaviour of people manifesting pain and the multiple affective and cognitive systems regulating the reactions of observers. The distinction between automatic and controlled information processing systems appears valuable in interpreting both the reactions of people in pain and of observers whose attention is directed to understanding the experience of the person in pain. The appraisal of the observer appears driven by both self interest and altruistic concern. The experience of pain in others can alert observers to risk of personal danger, as well as the potential that the other person requires care. Spontaneous (automatic) expressions of pain are more likely to instigate strong empathic reactions in observers, whereas controlled expressions that lack spontaneity are more likely to lead to questions about credibility. Understanding the complexities of the interaction between persons in pain and those reacting to them is likely to enhance delivery of care.

Figure 1:

		EXPRESSION OF PERSON IN PAIN	
OBSERVER REACTION		Automatic (reflexive escape, facial grimaces, cry)	Controlled (deliberate self- report, purposive actions)
	Automatic (involuntary, gut level)	LIKELY: involuntary emotional responses	LESS LIKELY (but possible)
	Controlled (contemplation, active decision- making)	PARALLEL: including delayed reflection	LIKELY (reflection, question credibility)

Figure 1. A representation of the probable reactions of observers to automatic and expressive displays of people in pain. Automatic expression is likely to instigate automatic, emotional reactions, as well as parallel cognitive appraisal. Controlled expression is less likely to evoke powerful automatic/emotional reactions in observers, but will instigate reflection and interest in various sources of the expression.

1. List of references

1. Baird AA, Fugelsang JA: The emergence of consequential thought: evidence from neuroscience. *Phil Trans R Soc Lond* 359: 1797-1804, 2004
2. Bargh JA, Chartrand TL: The unbearable automaticity of being. *Amer Psychol* 54: 462-479, 1999
3. Bargh JA, Williams EL: The automaticity of social life. *Curr Dir in Psychol Sci* 15: 1-4, 2006
4. Beck AT, Clark DA: An information processing model of anxiety: Automatic and strategic processes. *Behav Res and Ther* 35: 49-58, 1997
5. Bennett-Branson SM, & Craig KD: Postoperative pain in children: Developmental and family influences on spontaneous coping strategies. *Can J Behav Sci* 25, 355-383, 1993
6. Bradley MM, Silakowski T, Lang PJ: Fear of pain and defensive activation. *Pain* 137: 156-163, 2008
7. Brothers L: A biological perspective on empathy. *Amer J Psychiat* 146:1521-2, 1989
8. Botvinick M, Jha AP, Bylsma LM, Fabian SA, Solomon PE, Prkachin KM: Viewing facial expressions of pain engages cortical areas involved in the direct experience of pain. *Neuroimage*, 25: 312-319, 2005
9. Campbell CM, France CR, Robinson ME, Logan HL, Gefken GR, Fillingim RB: Ethnic differences in the nociceptive flexion reflex (NFR). *Pain* 134: 91-96, 2008
10. Cheng Y, Lin Cp, Liu HL, Hsu YY, Lim Ke, Hung D, Decety J: Expertise modulates the perception of pain in others. *Current Biology* 17: 1-6, 2007
11. Chou R, Fu R, Carrion JA, Deyo RA: Imaging strategies for low-back pain: Systematic review and meta-analysis. *Lancet* 373: 463-472, 2009.
12. Clow KA, Esses VM: Expectancy effects in social stereotyping: Automatic and controlled processing in the Neely Paradigm. *Can J Behav Sci* 39: 161-173, 2007

13. Cosmides L, Tooby J: Cognitive adaptations for social exchange. in Barkow JH, Cosmides L, Tooby J (eds.): *The Adapted Mind: Evolutionary psychology and the generation of culture*. New York NY, Oxford University Press, 1992, 163-228
14. Cowley AW, Cowley T, Norton NJ, Norton WF: Foreword, in Mayer EA, Bushnell MC (eds.): *Functional pain syndromes: Presentation and pathophysiology*. Seattle, WA, IASP Press, 2009, pp. xiii
15. Craig AD: A new view of pain as a homeostatic emotion. *Trends in Neurosciences* 26: 303-307, 2003
16. Craig KD: Physiological arousal as a function of imagined, vicarious and direct stress experiences. *J Abnorm Psychol* 73: 513-520, 1968
17. Craig KD: The construct and definition of pain in developmental disability, in Symons FJ, Oberlander TF (eds): *Pain in Individuals with Developmental Disabilities*. Baltimore, USA, Paul H. Brookes, 2006, pp 7-18
18. Craig KD: Assessment of credibility, in RF Schmidt, WD Willis (eds.): *The Encyclopaedia of Pain*. Berlin, Springer, 2006, pp. 491-493
19. Craig KD: The social communication model of pain. *Can Psychol* 50: 22-32, 2009
20. Craig KD, Badali MA: Introduction to the Special Series on the Detection of Pain Deception and Malingering. *Clin J Pain* 20: 377-382, 2004
21. Craig KD, Hadjistavropoulos T: Psychological perspectives on pain: Controversies, in Hadjistavropoulos T, Craig KD (eds.): *Pain: Psychological perspectives*. Mahwah, NJ, Lawrence Erlbaum, 2004, pp. 303-326
22. Craig KD, Hyde SA, Patrick CJ: Genuine, suppressed, and faked facial behavior during exacerbation of chronic low back pain. *Pain* 46: 161-172, 1991

23. Craig KD, Korol CT: Developmental issues in understanding, assessing, and managing pediatric pain, in Walco G, Goldschnieder K (eds.): *Pediatric Pain Management in Primary Care: A Practical Guide*. Totowa, NJ, The Humana Press Inc, 2008, pp. 9-20
24. Craig KD, Prkachin KM, Grunau RVE: The facial expression of pain, in Turk DC, R Melzack (eds.): *Handbook of Pain Assessment*, 2nd ed. New York, NY, Guilford, 2001, pp. 153-169
25. Craig KD, Stanford EA, Fairbairn NS, Chambers CT: Emergent pain language communication competence in infants and children. *Enfance* 1: 52-71, 2006
26. Crombez G, Eccleston C: To express or suppress may be function of others' distress. *Behav Brain Sci* 25: 457, 2002
27. de Waal FBM: Putting the altruism back into altruism: The evolution of empathy. *Ann Rev Psychol* 59: 279-300, 2008
28. Decety J, Jackson PL: The functional architecture of human empathy. *Behav and Cog Neurosci Rev* 3: 71-100, 2004
29. Decety J, Michalska KJ, Akitsuki Y: Who caused the pain? An fMRI investigation of empathy and intentionality in children. *Neuropsychologia* 46: 2607-2614, 2008
30. Eisenberg N, Strayer J: *Evolutionary bases of empathy: Empathy and its development*. Cambridge, NY, Cambridge University Press. 1987
31. Ekman, P, Rosenberg E (eds.): *What facial expression reveals about emotions, development, psychopathology and health*. (Second edition). Oxford, UK, Oxford University Press, 2005
32. Fazio RH: On the automatic activation of associated evaluations: An overview. *Cog and Emot* 15: 115-141, 2001
33. Fazio RH, Hilden LE: Emotional reactions to a seemingly prejudiced response: The role of automatically-activated racial attitudes and motivation to control prejudiced reactions. *Person Soc Psychol Bull* 27: 538-549, 2001

34. Feldman Barrett L, Ochsner KN, Gross JJ: Automaticity and emotion. In J. Bargh (Ed.). *Social Psychology and the Unconscious* New York, NY, Psychology Press, 2007, pp. 173-218
35. Ford GK, Finn DP: Clinical correlates of stress-induced analgesia: Evidence from pharmacological studies. *Pain* 140: 3-7, 2008
36. France CR, France JL, Absi MA, Ring C, McIntyre D: Catastrophizing is related to pain ratings, but not nociceptive flexion reflex threshold. *Pain* 99: 459-463, 2002
37. Fridlund AJ: *Human facial expression: An evolutionary view*. San Diego, CA, Academic, 1994
38. Goubert L, Craig KD, Vervoort T, Morley S, Sullivan MJL, Williams A, Cano A, Crombez G: Facing others in pain: the effects of empathy. *Pain* 118: 286-288, 2005
39. Goubert L, Craig KD, Buysse A: Perceiving others in pain: Experimental and clinical evidence on the role of empathy. in Ickes W, Decety J (eds.): *The Social Neuroscience of Empathy*. Massachusetts: The MIT Press, 2009, pp. 153-165
40. Goubert L, Vervoort T, Cano A, Crombez G : Catastrophizing about their children's pain is related to higher parent-child congruency in pain ratings: an experimental investigation. *Eur J Pain* 13: 196-201, 2009
41. Goubert L, Vervoort T, Crombez G : Pain demands attention of others: the approach/avoidance paradox. *Pain*: 143, 5-6, 2009
42. Grunau RVE, Craig KD: Pain expression in neonates: Facial action and cry. *Pain* 28: 395-410, 1987
43. Hadjistavropoulos T, Craig KD A theoretical framework for understanding self-report and observational measures of pain: A Communications Model. *Behav Res Ther* 40: 551-570, 2002
44. Hadjistavropoulos HD, Craig KD, Hadjistavropoulos T, Poole GD: Subjective judgments of deception in pain expression: Accuracy and errors. *Pain*, 65: 247-254, 1996

45. Hadjistavropoulos T, Craig KD: Social influences and the communication of pain. in
Hadjistavropoulos T, Craig KD (eds.): *Pain: Psychological Perspectives*. New York, NY: Lawrence
Erlbaum, 2004, pp 87-112
46. Hadjistavropoulos T, von Baeyer C, Craig KD: Pain assessment in persons with limited ability to
communicate. in Turk DC, Melzack R (eds.): *Handbook of Pain Assessment*, 2nd Ed. New York,
NY. Guilford, 2001, pp. 134-149
47. Heider F: *The Psychology of Interpersonal Relations*. New York, NY, John Wiley & Sons, 1958
48. Hill ML, Craig KD: Detecting deception in pain expressions: The structure of genuine and deceptive
facial displays. *Pain* 98: 135-144, 2002
49. Hill ML, Craig KD: Detecting deception in facial expressions of pain: Accuracy and training. *Clin J*
Pain 20: 415-422, 2004
50. Jackson PL, Meltzoff AN, Decety J: How do we perceive the pain of others? A window into the
neural processes involved in empathy. *NeuroImage* 24: 771-779, 2005
51. Jensen MP, Karoly P: Self-report scales and procedures for assessing pain in adults. In Turk DC,
Melzack R (eds): *Handbook of Pain Assessment*. New York, NY, Guilford. 2001, pp. 15-34
52. Jurado MB, Rosselli J: The elusive nature of executive functions: A review of our current
understanding. *Neuropsychol Rev* 17: 213-233, 2007
53. Keefe FJ, Williams DA, Smith SJ: Assessment of pain behaviours. in Turk DC, R Melzack (eds.):
Handbook of Pain Assessment. New York, NY, Guilford. 2001, pp. 170-187
54. Kleck RE, Vaughan RC, Cartwright-Smith J, Burns J, Vaughan KB, Colby CA, Lanzetta JT: Effects
of being observed on expressive, subjective, and physiological responses to painful stimuli. *J*
Pers Soc Psychol, 34: 1211-1218, 1976
55. Kunz M, Mylius V, Schepelmann K, Lautenbacher S: On the relationship between self-report and
facial expression of pain. *J Pain* 5: 368-376, 2004

56. Labus JS, Keefe, FJ, Jensen MP: Self-reports of pain intensity and direct observations of pain behaviour: when are they correlated? *Pain* 102: 109-124, 2003
57. Lamm C, Batson CD, Decety J: The neural substrate of human empathy: effects of perspective-taking and cognitive appraisal. *J Cog Neurosci* 19: 42-58. 2007
58. Larochette AC, Chambers CT, Craig KD: Genuine, suppressed and faked facial expressions of pain in children. *Pain* 126: 64-71, 2006
59. Malle BF: How people explain behaviour: A new theoretical framework. *Pers Soc Psychol Rev* 3: 23-48, 1999
60. Malle BF: Three puzzles of mindreading, in Malle BF, Hodges SD (eds): *Other Minds: How Humans Bridge the Divide between Self and Others..* New York, NY, Guilford Press. 2007, pp. 26-43
61. Marquie L, Raufaste E, Lauque D, Marine C, Ecoiffier M, Sorum P: Pain ratings by patients and physicians: Evidence of systematic pain miscalibration. *Pain* 102: 289-296, 2003
62. Moors A, De Houwer J: Automaticity: A theoretical and conceptual analysis. *Psych Bull* 132: 297-326, 2006
63. Ochsner KN, Zaki J, Hanelin J, Lodlow DH, Knierim K, Ramachandran T, Glover GH, Mackey SC:.. Your pain or mine? Common and distinct neural systems supporting the perception of pain in self and other. *Soc Cog Affect Neurosci* 3: 144-160, 2008
64. Ohman A, Mineka S: Fears, phobias and preparedness: Toward an evolved module of fear and fear learning. *Psychol Rev* 108: 483-522, 2001
65. Pillai Riddell RR, Craig KD: Judgments of infant pain: The impact of caregiver identity and infant age. *J Ped Psychol* 32: 501-511, 2007
66. Pinker S: *The Stuff of Thought: Language as a Window into Human Nature.* London UK, Penguin, 2007

67. Poole GD, Craig KD: Judgments of genuine, suppressed and faked facial expressions of pain. *J Pers Soc Psychol* 63: 797-805, 1992
68. Prkachin KM, Craig KD: Expressing pain: The communication and interpretation of facial pain signals. *J Nonverb Behav* 19: 191-205, 1995
69. Prkachin KM, Craig KD: Influencing non-verbal expressions of pain: Signal detection analyses. *Pain* 21: 399-409, 1985
70. Prkachin KM, Solomon PE, Ross J: Underestimation of pain by health care providers: Towards a model of the process of inferring pain in others. *Can J Nurs Res* 39: 88-106, 2007
71. Prochazka A, Clarac F, Loeb GE, Rothwell JC, & Wolpaw JR: What do *reflex* and *voluntary* mean? Modern views on an ancient debate. *Exp Brain Res* 130: 417-432, 2000
72. Schneider W, Chein JM: Controlled & automatic processing: behaviour, theory, and biological mechanisms. *Cog Sci* 27: 525-559, 2003
73. Simon D, Craig KD, Miltner WHR, Rainville P: Brain responses to dynamic facial expressions of pain. *Pain* 126: 309-318, 2006
74. Simon D, Craig KD, Gosselin F, Belin P, Rainville P: Recognition and discrimination of prototypical dynamic expressions of pain and emotions. *Pain* 135: 55-64, 2008
75. Singer T, Seymour B, O'Doherty JP, Stephan KE, Dolan RJ, Frith CD: Empathic neural responses are modulated by the perceived fairness of others. *Nature* 439(7075): 466-469, 2006
76. Singer T, Seymour B, O'Doherty J, Kaube H, Dolan R, Frith CD: Empathy for pain involves the affective but not sensory components of pain. *Science* 303: 1157-1162, 2004
77. Smith ER, DeCoster J: Dual-process models in social and cognitive psychology: Conceptual integration and links to underlying memory systems. *Pers Soc Psychol Rev* 4: 108-131, 2000
78. Stinson JN, Kavanagh T, Yamada J, Gill N, Stevens BJ: Systematic review of the psychometric properties, interpretability and feasibility of self-report pain measures for use in clinical trials in children and adolescents. *Pain* 125: 143-157, 2006

79. Stuss DT, Alexander MP: Executive functions and the frontal lobes: a conceptual review. *Psychol Res* 63: 289-298, 2000
80. Sullivan MJL: Toward a biopsychomotor conceptualization of pain. *Clin J Pain* 24: 281-290, 2008
81. Sullivan MJL, Adams H, Sullivan ME: Communicative dimensions of pain catastrophizing: Social cueing effects on pain behaviour and coping. *Pain* 107: 220-226, 2004
82. Tait RC, Chibnall JT, Kalauokalani D: Provider judgments of patients in pain: Seeking symptom certainty. *Pain Med* 10: 11-34, 2009
83. Turk DC, Melzack R (eds): *Handbook of Pain Assessment*, 2nd ed. New York, NY, Guilford, 2001
84. Vancleef LMG, Peters ML, Gilissen SMP, De Jong PJU: Understanding the role of injury/illness sensitivity and anxiety sensitivity in (automatic) pain processing: An examination using the extrinsic affective Simon Task. *J Pain* 8: 563-572, 2007
85. Vervoort T, Goubert L, Eccleston C, Verhoeven K, De Clercq A, & Buysse A, & Crombez G: The effects of parental presence upon the facial expression of pain: the moderating role of child pain catastrophizing. *Pain* 138: 277-285, 2008
86. Vervoort T, Goubert L, Crombez G: The relationship between high catastrophizing children's facial display of pain and parental judgment of their child's pain. *Pain* 142: 142-148, 2009
87. Vogel G: The evolution of the golden rule. *Science* 303: 1128-1131, 2004
88. Wall PD: *Pain: The science of suffering*. Weidenfeld and Nicolson, 1999
89. Werner A, Malerud K: It is hard work behaving as a credible patient: encounters between women with chronic pain and their doctors. *Soc Sci Med* 57: 1409-1419, 2003
90. Williams ACdeC: Facial expression of pain: an evolutionary account. *Behav Brain Sci* 25: 439-488, 2002
91. Williams ACdeC, Craig KD: A science of pain expression? *Pain* 125: 202-203, 2006
92. Yamada M, Decety J: Unconscious affective processing and empathy: An investigation of subliminal priming on the detection of painful facial expressions. *Pain* 143: 71-75, 2009

Figure Legend

Figure 1. A representation of the probable reactions of observers to automatic and expressive displays of people in pain. Automatic expression is likely to instigate automatic, emotional reactions, as well as parallel cognitive appraisal. Controlled expression is less likely to evoke powerful automatic/emotional reactions in observers, but will instigate reflection and interest in various sources of the expression.

Kenneth D. Craig

Formatted: Line spacing: Double

Focus Article

Perceiving Pain in Others: Automatic and Controlled Mechanisms

Kenneth D. Craig^a, Judith Versloot^a, Liesbet Goubert^b, Tine Vervoort^b, and Geert Crombez^b

^aUniversity of British Columbia

^bGhent University

Note: Corresponding author for this manuscript is Dr. Kenneth D. Craig, 2136 West Mall,
Vancouver, B.C., Canada V6T 1Z4. Tel.: 604 822 3948; Fax: 604 822 6923; email:
kcraig@psych.ubc.ca

Field Code Changed

Author Information:

Kenneth D. Craig, PhD

Judith Versloot, PhD

2136 West Mall

2136 West Mall

Department of Psychology

Department of Psychology

University of British Columbia

University of British Columbia

Vancouver, B.C.

Vancouver, B.C.

Canada V6T 1Z4

Canada V6T 1Z4

jversloot@psych.ubc.ca

Kenneth D. Craig

Liesbet Goubert, PhD

Department of Experimental-Clinical and

Health Psychology

Ghent University

Henri Dunantlaan 2,

9000 Gent, Belgium

Liesbet.Goubert@UGent.be

Tine Vervoort, PhD

Department of Experimental-Clinical and

Health Psychology

Ghent University

Henri Dunantlaan 2,

9000 Gent, Belgium

Tine.Vervoort@UGent.be

Geert Crombez

Department of Experimental-Clinical and

Health Psychology

Ghent University

Henri Dunantlaan 2,

9000 Gent, Belgium

Geert.Crombez@ugent.be

Field Code Changed

Running title: Perceiving others' pain

Key words: assessment, expression, empathy, reflexes, self-report, credibility

Kenneth D. Craig

Abstract

Recent developments in clinical, cognitive and behavioural sciences as well as in social neuroscience can provide new perspectives on our understanding of different forms of pain expression and the social reactions of observers to various types of pain expression. Studies indicate that pain expression is governed by both automatic (unintentional, reflexive) and controlled (intentional, purposive) neuroregulatory systems. Reciprocal mechanisms in observers responsible for automatic (unintentional, reflexive) and controlled (intentional, reflective) reactions also appear important. Observers appear more likely to display immediate “visceral”, emotional reactions to unintentional, reflexive expression, whereas controlled expression characterized by purposive, articulated behaviour appears more likely to elicit contemplative reflection on the nature and origins of the person’s pain. This review summarizes pertinent research within the context of a theoretical model for understanding how pain is perceived in others.

Perspective: People attempting to understand another person’s pain may have access to the person’s spontaneous behavioural reaction as well as verbal report and other purposive communications. The former instigates reflexive and emotional reactions whereas the latter tends to be perceived as confounding expression of experience with response to situational demands.

Perceiving Pain in Others: Automatic and Controlled Mechanisms

Recognizing and interpreting the significance of pain expression in others can be of great importance to the suffering person and the person witnessing the other's distress. Various actions, including language, paralinguistic vocalizations, facial expression, body posture, and escape or avoidance behaviour, may signal pain to others. These events can command the attention of observers from perspectives of both self-interest and social beneficence (and sometimes malevolence). They permit recognition of potential danger and provide opportunity for harm avoidance at the same time as they allow appreciation of what is happening to the person in pain, perhaps leading to provision of ~~care~~³⁷ care^{45, 3341, 8092}. The adaptive value of responding to pain in others is embedded in the evolutionary history of humans and ancestral ~~species~~⁶ species^{7, 2227, 2430.87, 7890}. Despite its importance, the study of the social transaction initiated by pain expression is not well ~~developed~~⁷⁰ developed^{80, 82, 79, 91} although it is fundamental for understanding pain assessment in research and clinical ~~practice~~⁷³ practice⁸³.

Recent developments in clinical, cognitive and behavioural sciences as well as in social neuroscience can provide new perspectives on our understanding of different forms of pain expression and the social reactions of observers. Studies indicate that pain expression is governed by both automatic (unintentional, reflexive) and controlled (intentional, purposive) neuroregulatory ~~systems~~³⁵ systems⁴³. Reciprocal mechanisms in observers responsible for automatic (unintentional, reflexive) and controlled (intentional, reflective) reactions also appear important. This review summarizes research within a theoretical model of how pain is perceived in others.

The Background

Tapping into the pain experience of another through use of painful expression is a challenging task. Expression can only partially represent the complexity of the subjective experience; hence, they are not equivalent ~~or isomorphic~~^{1626, 3543, 4755, 4856, 7586}. At the neurobiological level of analysis, different systems are associated with pain experience and expression. Studies of sensory and affective features of

Comment [KD1]: Vogel, G. (2004). The evolution of the golden rule. *Science*, 303, 1128-1131.

Formatted: Font: 12 pt

Comment [KD2]: Tait RC, Chibnall JT, Kalauokalani D: Provider judgments of patients in pain: Seeking symptom certainty. *Pain Medicine* 10: 11-34, 2009

Formatted: Font: 12 pt

Formatted: Superscript

Kenneth D. Craig

pain experience have focused upon afferent nociceptive and neuropathic mechanisms and central

~~processing~~⁴⁴ processing¹⁵, whereas investigations of pain expression necessitate examination of systems responsible for language and efferent neuromotor regulatory ~~mechanisms~~⁷⁶ mechanisms^{80,88,70}.

Operationalizing the distinction between pain experience and expression poses problems. From the research perspective, experience cannot be studied through other than some form of expression.

Inevitably, understanding the pain experience of another requires inference. One can identify various cues to be important ~~in-for~~ observer judgments in the behaviour of the person in pain (self-report, other features of vocalizations, facial activity, body activity, limb withdrawal, writhing, and other nonverbal behaviors). Other evidence such as ~~can be important. For example,~~ the presence of precipitants of injury^{42,50,61}, actual bodily injury, and physiological response to tissue stress or pathology⁵ can also influence judgements. However, the presence and experience of pain are often poorly related to the nature and magnitude of tissue stress or damage¹¹. The inferences and judgments of observers necessitate attention to the behavioural reactions of the person in pain.

The primary resources available for examining the subjective experience of pain are self-report and nonverbal expression, categories of pain response that are readily differentiated and usually identified as conceptually different. In tightly controlled studies, they can be highly ~~correlated~~⁴⁷ correlated⁵⁵; more typically they are only modestly correlated, with contextual factors determining the magnitude of the ~~relationship~~⁴⁸ relationship^{56, 64,70}.

In competent, well-motivated people, self-report can provide a valid estimate of pain. But the need for competence in cognitive functioning and the potential for biased responses reflecting sufferer expectations and needs cannot be ~~ignored~~⁴³ ignored^{51, 69,78}. The individual's perception of optimal performance and outcome in a given setting appears crucial and determines self-presentation. Those assessing the person for pain also may bias self-report by providing cues as to what level of report is expected or appropriate. Thus, self-report must be recognized as representing some combination of expression of personal experience and a response to an appraisal of the immediate situation.

Comment [KD3]: Bennett-Branson, S.M., & Craig, K.D. (1993). Postoperative pain in children: Developmental and family influences on spontaneous coping strategies. *Canadian Journal of Behavioural Science*, 25, 355-383.

Formatted: Font: 12 pt

Formatted: Superscript

Comment [KD4]: Chou R, Fu R, Carrion JA, Deyo RA: Imaging strategies for low-back pain: Systematic review and meta-analysis. *Lancet* 373: 463-472, 2009.

Formatted: Font: 12 pt

Formatted: Superscript

Formatted: Font: Italic

Kenneth D. Craig

Nonverbal expression typically is endorsed as important when infants, young children, seniors with dementia, or others with communication limitations are unable to provide self-report^{13, 38, 46}. However, nonverbal assessment is also important in everyday and clinical social discourse. Nonverbal expression typically adds context and meaning to language and can be perceived as more credible than self-report because it is not as subject to conscious control as the use of language⁶⁷. But similar to self-report, nonverbal expression is not exclusively reflexive. It also confounds subjective experience and situational demands. Nonverbal expression is sensitive to audiences⁴⁶,^{54, 71, 6069, 81, 7485}. People also can be reasonably successful in suppressing or exaggerating nonverbal pain expression²⁴,^{26, 4048, 3644, 5058}, in accordance with perception of situational demands, thereby again confounding spontaneous with socially predicated expression. It is not surprising that observers, clinicians or otherwise, experience difficulties in determining whether either self-report or nonverbal behaviour represent manifestations of pain experience or reactions to self-serving or situational demand biases.

We propose an alternative classification that distinguishes between automatic, reflexive features of the response to pain, perhaps best illustrated by the protective nociceptive flexion reflex²⁹,^{36, 89}, and expressions of pain that reflect higher levels of central processing or purposive, deliberative control. Automatic reactions, whether in response to pain or other life events, tend to be sufficiently transparent so as to signify their direct meaning, and include “screaming in pain, laughing with joy, and growling with anger”⁵²⁶⁰, (p. 29). Controlled, intentional expression is typified by the use of language for self-report purposes but also would include integrated sequences of instrumental motor activity³⁵,^{43, 4856}. The distinction is important because observers are disposed to attributing causes to other persons’ actions³⁹,^{47, 5459}. Reflexive activity is considered to have quite different functional implications than activities that are suggestive of deliberate intention and executive control. Complexity is added by the reality that although pain behaviour may be unintentional (e.g., facial expression, or even

Formatted: Font: Italic

Comment [KD5]: Ekman, P, Rosenberg E (eds.): What facial expression reveals about emotions, development, psychopathology and health. (Second edition). Oxford, UK.: Oxford University Press, 2005

Formatted: Font: 12 pt

Kenneth D. Craig

nociceptive pain reflexes), it ~~is~~ can be controllable to a certain extent (e.g., inhibiting facial expression, exaggerating withdrawal reactions, etc.)^{44,52, 59,68, 71}.

The distinction between systems that are automatic, on the one hand, or subject to processing and control, on the other, also characterizes observer reactions. Witnessing others reacting to acute painful events is capable of instigating immediate “visceral” or gut level emotional ~~experiences~~¹² experiences¹⁶. The rapidly unfolding social neuroscience literature on cerebral correlates of witnessing others in painful distress documents the brain states to be ~~observed~~⁴² observed^{50, 54,63, 64,73}. These automatic, uncontrollable reactions are accompanied by immediate attention and parallel controlled reflective appraisal of the nature of the other person’s situation, as well as attention to likely sources of the activity observed, as the observer seeks to understand what is happening to the other person.

The theoretical distinction between two major observable behavioural sources of information concerning another person’s pain experience and two major patterns of reacting to others in pain arises from theoretical and empirically derived models of information processing implicating at the extremes automatic and controlled mechanisms, with these interrelated and operative in varying ~~degrees~~⁵² degrees^{62, 27,34}. The proposition that human performance results from an interplay between automatic and controlled processing of ~~information~~⁶³ information⁷² is predicated upon the understanding that in complex environments attention must be guided to process critical stimuli, yet other routine, well rehearsed and overlearned activities are executed repetitively without demands on attention. yet other vegetative and well rehearsed actions occur without direction. It has been applied to understanding social interaction phenomena in other ~~contexts~~⁶⁸ contexts^{77, 2, 3} including study of such phenomena as automatic stereotype ~~activation~~² activation^{2, 40, 12}.

The following elaborates on this distinction as it contributes to understanding how those experiencing pain react and how observers respond to different forms of pain display.

Automatic and Controlled Features of the Behaviour of the Person in Pain

Systematic differences in the categories of painful expression set the occasion for variation in how observers perceive and respond to the person in pain.

Unintentional expressions of painful experience. Automatic pain manifestations are involuntary, spontaneous, triggered, stereotyped, predisposed sets of behavioural reactions elicited by noxious stimuli. They accompany but do not wholly or exclusively represent the sensory, affective and cognitive features of pain. From a physiological perspective, they are the somatomotor features of the coordinated central, hormonal, and autonomic response to tissue insult that have the relatively distinctive character of preparing the person to defend against tissue damage, ~~in all its complexity~~.

In considering types of automatic behaviour it is useful to distinguish between observable actions that are directly protective, because they permit escape or avoidance of sources of pain, and those that are indirectly protective because they communicate distress to others, thereby eliciting their protective interventions^{79,80}. The former are represented by withdrawal reflexes and assuming guarded ~~postures~~⁴⁵ postures⁵³. They act largely outside conscious awareness and deliberation. Communicative actions can also be reflexive or automatic. Infant behavioural reactions to painful events are reasonably seen as evolved protective behaviour, with control only emerging later on in ~~infancy~~¹⁸ infancy^{23, 34,42, 52,60}. During the earliest moments and months of life, some of the protective behaviour is primarily in the form of social communication, for example, crying or facial expression, thereby informing parents and other adults potentially able to intervene with sources of distress and/or ~~danger~~³⁴ danger⁴².

Many communicative and other protective actions are reasonably construed as biologically prepared and unlearned. In older children and adults, continuity and stereotypy in various manifestations of pain can be ~~observed~~¹⁸ observed²³. Features of facial expression, paralinguistic qualities of speech, guarded behaviour and protective posture would appear to satisfy criteria for unintentional signs of pain, i.e., they are reflexive, display striking structural and functional consistency across the life span, the person largely is not ~~cognizant-aware~~ of them, but they can be controlled to a certain extent. Criteria for automatic actions, as defined by Moors & De Houwer⁶² include processing at

a relatively non-conscious level, efficiency in terms of not requiring effortful processing, absence of a formulated goal, and being purely stimulus driven (see criteria for the automatic/controlled distinction in Moors & De Houwer⁵³). Concerning observable actions relevant to social communication, facial expression is typically the most salient and instructive for the observer¹⁹ observer^{24, 6470, 7890}. A relatively stereotyped facial display of pain has been identified that is distinguishable from other non-noxious emotional and other states, both behaviourally, in the judgments of others⁶⁵ others⁷⁴ and in observer brain states observed documented through neuro-imaging⁶⁴ imaging⁷³, but other socially relevant actions may be identifiable, for example, cry and paralinguistic qualities of speech.

Automatic responses are expected to be relatively stimulus driven and independent of attention and contextual influence⁵³ influence⁶². However, it is clear that emotional and cognitive factors may modify reflexive responses, for example, stress induced analgesia is capable of diminishing reflexive withdrawal responses in rats and humans²⁸ humans³⁵ and negative emotions can potentiate startle in humans⁵ humans⁶. While facial expression is a candidate for relatively immediate responding without conscious attending to the display, it is context-sensitive and linked to environmental demands. For example, presence of an audience of strangers tends to inhibit facial expression of pain⁴⁶ pain⁵⁴, although children who engage in high levels of catastrophizing appear to indiscriminately display pain and are less likely to suppress pain expression⁷⁵ expression⁸⁶. Furthermore, automatic responses are to some extent subject to voluntary control, for example, suppression⁶² suppression⁷¹ or enhancement⁴⁰ enhancement⁴⁸. As children mature, originally automatic manifestations of pain come at least partially under voluntary control. For example, the essentially reflexive crying of the neonate becomes more of a speech act²⁰ act²⁵ and children learn to suppress pain expression in the presence of peers when negative reactions are anticipated⁵⁰ anticipated⁵⁸. Control can be achieved over facial displays of pain¹⁷ pain²², including both exaggeration and suppression of the display; however, the exaggerated display differs from the genuine display in subtle ways⁴¹ ways⁴⁹, and neither faking nor suppression of facial displays are wholly successful³⁶ successful^{44, 5867}.

Kenneth D. Craig

Intentional expressions of painful experience. These can be construed as typically deliberate, conscious, and coordinated by executive functions¹. The latter are implicated when complex cognitive sub-processes such as planning, anticipation, and decision-making become engaged. The use of language appears to best illustrate controlled expression of pain. It is noteworthy that complex, coordinated or innovative responses to situational demands can come to be relatively automatic, in this instance enacted without deliberation, when thoroughly well rehearsed in particular situations^{3, 53, 62}.

Understanding controlled expression would appear to be more important to understanding human pain expression, although continuity in controlled expression across primate species is ~~evident~~²² evident²⁷. Interaction between automatic reactions and controlled expressions would be expected, with the latter coming to modulate the former in the course of human ontogeny, but there are limits to the extent that automatic expressions can be over-ridden by conscious control.

Automatic and Controlled Features of Perceiving Pain in Others

Cues related to pain in another person have the potential to influence observer perception of pain, some as a result of automatic activation, with others acquiring meaning only through conscious deliberation and executive processing. The act of perceiving others in pain has been characterized in a theoretical model of pain empathy as the product of both bottom-up and top-down ~~variables~~³⁰ variables^{38, 34, 39}. “Bottom-up” information is derived through perception of the actions of the person manifesting pain. The concept refers primarily to automatic reactions to the painful reactions of others and would implicate the detection of pain. This is appraised and achieves significance for the observer through utilization of “top-down” information reflecting application of the beliefs, expectancies, attitudes and biases of the observer, a process characterized by greater levels of controlled processing..

Automatic Reactions. These are characterized as reflexive, intuitive, automatic “gut feelings” evoked by the pain reactions of others. These “visceral” reactions are reasonably construed as more ancient in their evolutionary origins, conserved across phyla by virtue of their functional advantages in warning, motivating and protecting progenitors, thereby increasing reproductive fitness. There would

Comment [KD6]: The original pdf submitted included material at the beginning of this section that should have been deleted. It read “Cues related to pain in another person have the potential to influence observer perception of pain, some as a result of automatic activation, with others acquiring meaning only through conscious deliberation and executive processing. Automatic processing can be bottom-up or stimulus driven”. This was unclear and incomplete and is thoroughly addressed elsewhere. It has been deleted in this draft.

Formatted: Font: 12 pt

Kenneth D. Craig

appear to be automatic processing of cues through biologically prepared innate, unconditioned feature detectors that give rise to reflex-like responses. Current brain imaging studies of biological reactivity demonstrate a powerful and immediate biological impact of the experience of observing-witnessing others in pain on observers^{7, 8, 2328, 4250, 5463, 6473, 6776}.

Reactions are influenced by contextual factors (e.g., setting and social cues, and characteristics of the person in pain^{15, 19, 29, 3240, 49, 57}). The relationship between the observer and the person in pain can dictate the reaction and perhaps commitment to the person in pain. This is evident in both behavioural and brain imaging studies (e.g., professional, family, stranger). For example, judgements of pain in infants differ systematically across parents, nurses and pediatricians⁵⁶ -pediatricians⁶⁵ and the perceived fairness of others expressing pain were found to modulate empathic neural responses⁶⁶ responses⁷⁵.

Automatic reaction patterns would not be restricted to reflexive or autonomic activation, but could include automatic instigation of thoughts, beliefs and biases. Inherent sensitivity would appear to involve matching of stimulus input to prepared schema, thereby instigating unconditioned and coordinated reaction patterns. In turn these reactions would be amenable to conditioning and yield templates that guide automatic evaluation of perceived threat and reactions thereafter^{4, 910, 5564, 7384}.

Controlled processing. When an observer attends to another person's plight, automatic reactions would be accompanied by efforts to understand and plan actions suitable to the situation⁷⁷. There is a need to know not only what is happening to the individual but also why this is happening, what sequence of events led to the person's painful distress, and what the person could do, or what the observer could do to resolve the situation. Problem-solving, memory, judgment, attitudes and biases are likely to be implicated. When an observer attends to another person's distress or situational demands dictate attention to the person's plight, a range of cognitive and affective processes are implicated in decision-making, including memory, problem-solving, judgment, various heuristics, attitudes and biases. This higher level of neuroregulatory information processing would implicate executive functions^{52, 79}.

Comment [KD7]: Decety J, Michalska KJ, Akitsuki Y: Who caused the pain? An fMRI investigation of empathy and intentionality in children. *Neuropsychologia* 46: 2607-2614, 2008

Formatted: Font: 12 pt

Formatted: Not Superscript/ Subscript

Comment [KD8]: Stuss DT, Alexander MP: Executive functions and the frontal lobes: a conceptual review. *Psychol. Res.* 63: 289-298, 2000

Formatted: Font: 12 pt

Kenneth D. Craig

Automatic processing is reasonably effortless or passive, with controlled processing more likely to predominate when conflicting or disconfirming evidence is present and active ~~processing-deliberation~~ is necessary to resolve ~~the contradiction~~ eng information and demands⁷⁷. Both unconscious processing and consciously guided conceptual-level processes would come into play, ~~deploying propositional knowledge to~~ allowing observer knowledge to refine judgements ~~of about~~ the nature of the other's distress. Thus, elements of automatic processing are implicated in controlled reactions. There would be consideration of risks and appraisal of strategies for harm avoidance for ~~both oneselfoneself~~ and the person in ~~pain~~ pain^{80, 92, 3341}. Beliefs (true and false), expectations, or prior knowledge would have an impact, as would ~~the capacity for higher level decision making~~, the capacity for self-regulation of emotions, and empathy. Reasoned appraisal should lead to a broad understanding of the other's experience, its origins and likely outcomes. While one can distinguish between bottom up and top down processes, they operate in parallel, with conscious processing persisting longer than the immediate spontaneous reaction³⁸.

Formatted: Superscript

Interactions between controlled and automatic processing in sufferers and observers

Observer reactions appear to vary systematically with the different categories of pain expression in the person being observed (see Figure 1 for a schematic representation of the interaction). Expression of pain indicative of automatic reactions to situations (reflexes, emotional reactions) instigates different reactions in observers than controlled reactions indicative of ~~personal agency~~ planned, goal-directed behavior. Thus, different manifestations of pain would not be equivalent to others in their capacity to instigate particular reaction patterns ~~(see Figure 1)~~.

Observer reactions to automatic expression. These stimulus driven reactions would be intuitive and immediate. The observer need only be passive, but the impact appears potent. Facial displays depicting vivid emotional expression have been found to be particularly effective in commanding attention and to be prepotent in their impact³⁷. ~~This is the default mode.~~ Little cognitive participation in the emotional reaction would be expected, although efforts to understand what is happening would also

Comment [KD9]: Fridlund, A.J. (1994). *Human facial expression: An evolutionary view*. San Diego, CA: Academic.

Formatted: Font: 12 pt

Formatted: Superscript

Kenneth D. Craig

be immediately instigated (controlled reactions). In the primordial world, through to the present, observing these reactions in others would instigate a sense of personal danger with fear for the other person a subordinate ~~response~~³⁷ response^{45,73,8092}.

It is noteworthy that the cues most likely to instigate emotional processing fall in the domains of raw visual or auditory experience. These sensory modalities are also basic to reading and speech but these human capabilities rely extensively upon more complex, learned cognitive skills. Linguistic and literacy skills come to be acquired slowly during development of the child, signalling the complexity of the cognitive processes engaged when language or written communications are used to convey information about painful states. The semantic features of self reports rely upon symbolic/linguistic mediation, or top down processing. However, paralinguistic ~~or prosodic~~ qualities of speech convey the emotional or mood status of the speaker and some forms of language (e.g., ~~cuss-swear~~ words, particularly evocative language used by authors or patients, or poetry) are capable of instigating immediate, vigorous visceral ~~reactions~~⁵⁷ reactions⁶⁶. Language also has a capacity to automatically instigate certain automatic appraisals of events from memory when objects of attitudes ~~objects~~ are encountered, for example, ~~prejudices~~²⁵ prejudices^{32, 2633}.

Observer r~~Reactions to intentional expression~~. While also immediate, these observer reactions would be of longer duration, as decoding and appraisal the of information and the appraisal would require complex and effortful⁶² cognitive processing. This would require attentional and problem solving resources, as effort was expended to sort out competing interpretations. The subtle nuances of language are important in differential diagnosis as alternative explanations of signs and symptoms are explored. In everyday social experience, when pain complaints are made, there must be similar searches among competing explanations of the origins of the individual's complaints. Listeners are likely to appreciate that the account is determined by both internal states being described and the speaker's appraisal of the situation.

Formatted: Superscript

Kenneth D. Craig

The suffering person's capacity to control expression would make the expression more difficult to understand, more ambiguous as to its origins, and less readily interpreted as the immediate product of specific stimuli. It seems less likely that controlled reactions alone would be capable of triggering ~~or instantiating~~, the same full empathic emotional reactions provoked by automatic bottom up stimuli, although, as discussed above, skilled narrators or writers seem capable of generating verbal scenarios capable of provoking resonant reactions in others. Patients often work hard to present convincing cases of the gravity of their condition make the objective/rational assessments less an intellectual experience and more an emotional drama⁷⁷⁸⁹.

Given awareness of the potential for voluntary control, risks of fabrication may be appraised.

People presenting with pain invariably are subject to careful appraisal by ~~others~~¹⁴ others^{18, 82}. While trust seems the accepted norm and clinicians are routinely enjoined to believe patient self-report of pain, optimal care giving and prudent stewardship of resources require judgements about the legitimacy of the representations of the person in distress. Medically unexplained pain appears particularly susceptible to doubts about the credibility of complaints. Patients for whom there is no scientific explanation of their pain are described as at risk of being marginalized from meaningful professional care and treatment¹⁴. In the absence of medical evidence for tissue damage or stress, examiners must rely upon symptom complaints; hence, credibility is likely to be questioned. Universal propensities to detect cheaters have been postulated by evolutionary biologists to account for careful scrutiny of others in social transactions^{13,20,48,49,90}. Prkachin, Solomon and ~~Ross~~⁶⁴ Ross⁷⁰ observed that suspicions surrounding the motivations of the patient impacted pain judgments during clinical decision making. Enjoining health care practitioners to utilize and believe self-report to some extent appears to be founded upon implicit recognition of the limited effectiveness of self-report in generating resonant feelings in observers.

Conclusions

Understanding the process whereby observers infer the presence and nature of pain in others requires an appreciation of the interaction between the expressive behaviour of people manifesting pain

Formatted: Superscript

Formatted: Superscript

Comment [KD10]: Cowley AW, Cowley T, Norton NJ, Norton WF: Foreword, in Mayer EA, Bushnell MC (eds.): Functional pain syndromes: Presentation and pathophysiology. Seattle, WA, IASP Press, 2009, pp. xiii

Formatted: Font: 12 pt

Formatted: Superscript

Comment [KD11]: Craig, K.D. & Badali, M.A. (2004). Introduction to the Special Series on the Detection of Pain Deception and Malingering. *Clinical Journal of Pain*, 20, 377-382. Cosmides L, Tooby J: Cognitive adaptations for social exchange. in Barkow JH, Cosmides L, Tooby J (eds.): The Adapted Mind: Evolutionary psychology and the generation of culture. New York NY, Oxford University Press, 1992, 163-228

Formatted: Superscript

Formatted: Superscript

Formatted: Superscript

Formatted: Font: 12 pt, Superscript

Formatted: Not Superscript/ Subscript

Kenneth D. Craig

and the multiple affective and cognitive systems regulating the reactions of observers. The distinction between automatic and controlled information processing systems appears valuable in interpreting both the reactions of people in pain and of observers whose attention is directed to understanding the experience of the person in pain. The appraisal of the observer appears driven by both self interest and altruistic concern. The experience of pain in others can alert observers to risk of personal danger, as well as the potential that the other person requires care. Spontaneous (automatic) expressions of pain are more likely to instigate strong empathic reactions in observers, whereas controlled expressions that lack spontaneity are more likely to ~~lack~~ lead to questions about credibility. Understanding the complexities of the interaction between persons in pain and those reacting to them is likely to enhance delivery of care.

Figure 1:

		EXPRESSION OF PERSON IN PAIN	
OBSERVER REACTION		Automatic (reflexive escape, facial grimaces, cry)	Controlled (deliberate self- report, purposive actions)
	Automatic (involuntary, gut level)	LIKELY: involuntary emotional responses	LESS LIKELY (but possible)
	Controlled (contemplation, active decision- making)	PARALLEL: including delayed reflection	LIKELY (reflection, question credibility)

Figure 1. A representation of the probable reactions of observers to automatic and expressive displays of people in pain. Automatic expression is likely to instigate automatic, emotional reactions, as well as parallel cognitive appraisal. Controlled expression is less likely to evoke powerful automatic/emotional reactions in observers, but will instigate reflection and interest in various sources of the expression.

Formatted: Font: 12 pt

1. List of references

1. Baird AA, Fugelsang JA: The emergence of consequential thought: evidence from neuroscience. *Phil Trans R Soc Lond* 359: 1797-1804, 2004

2. Bargh JA, Chartrand TL: The unbearable automaticity of being. *Amer Psychol* 54: 462-479, 1999

3. Bargh JA, Williams EL: The automaticity of social life. *Curr Dir in Psychol Sci* 15: 1-4, 2006

4. Beck AT, Clark DA: An information processing model of anxiety: Automatic and strategic processes. *Behav Res and Ther* 35: 49-58, 1997

5. Bennett-Branson SM, & Craig KD: Postoperative pain in children: Developmental and family influences on spontaneous coping strategies. *Can J Behav Sci* 25, 355-383, 1993

Formatted: English (U.S.)

Formatted: Line spacing: Double

Formatted: Font: Not Italic

Formatted: Font: Not Italic

56. Bradley MM, Silakowski T, Lang PJ: Fear of pain and defensive activation. *Pain* 137: 156-163, 2008

67. Brothers L: A biological perspective on empathy. *Amer J Psychiat* 146:1521-2, 1989

78. Botvinick M, Jha AP, Bylsma LM, Fabian SA, Solomon PE, Prkachin KM: Viewing facial expressions of pain engages cortical areas involved in the direct experience of pain.

NeuroImage, 25: 312-319, 2005

89. Campbell CM, France CR, Robinson ME, Logan HL, Gefken GR, Fillingim RB: Ethnic differences in the nociceptive flexion reflex (NFR). *Pain* 134: 91-96, 2008

910. Cheng Y, Lin Cp, Liu HL, Hsu YY, Lim Ke, Hung D, Decety J: Expertise modulates the perception of pain in others. *Current Biology* 17: 1-6, 2007

Formatted: Indent: Left: 0", Hanging: 0.5"

11. Chou R, Fu R, Carrion JA, Devo RA: Imaging strategies for low-back pain: Systematic review and meta-analysis. *Lancet* 373: 463-472, 2009.

Formatted: Font: 12 pt

Formatted: Indent: Left: 0", Hanging: 0.5", Line spacing: Double

102. Clow KA, Esses VM: Expectancy effects in social stereotyping: Automatic and controlled processing in the Neely Paradigm. ~~Canadian Journal of Behavioural Science~~ 39: 161-173, 2007

13. Cosmides L, Tooby J: Cognitive adaptations for social exchange. in Barkow JH, Cosmides L, Tooby J (eds.): The Adapted Mind: Evolutionary psychology and the generation of culture. New York NY, Oxford University Press, 1992, 163-228

14. Cowley AW, Cowley T, Norton NJ, Norton WF: Foreword, in Mayer EA, Bushnell MC (eds.): Functional pain syndromes: Presentation and pathophysiology. Seattle, WA, IASP Press, 2009, pp. xiii

145. Craig AD: A new view of pain as a homeostatic emotion. Trends in Neurosciences 26: 303-307, 2003

1216. Craig KD: Physiological arousal as a function of imagined, vicarious and direct stress experiences. ~~Journal of Abnormal Psychology~~ 73: 513-520, 1968

1317. Craig KD: The construct and definition of pain in developmental disability, in Symons FJ, Oberlander TF (eds): Pain in Individuals with Developmental Disabilities. Baltimore, USA, Paul H. Brookes, 2006, pp 7-18

4418. Craig KD: Assessment of credibility, in RF Schmidt, WD Willis (eds.): The Encyclopaedia of Pain. Berlin, Springer, 2006, pp. 491-493

4519. Craig KD: The social communication model of pain. Can Psychol 50: 22-32, 2009

20. Craig KD, Badali MA: Introduction to the Special Series on the Detection of Pain Deception and Malingered. Clin J Pain 20: 377-382, 2004

Formatted: Font: 12 pt

Formatted: Indent: Left: 0", Hanging: 0.5",
Line spacing: Double

Formatted: Font: 12 pt

Formatted: English (U.S.)

Formatted: Line spacing: Double

Formatted: Font: Not Italic

Formatted: English (Canada)

- ~~4621~~. Craig KD, Hadjistavropoulos T: Psychological perspectives on pain: Controversies, in Hadjistavropoulos T, Craig KD (eds.): Pain: Psychological perspectives. Mahwah, NJ, Lawrence Erlbaum, 2004, pp. 303-326.
- ~~4722~~. Craig KD, Hyde SA, Patrick CJ: Genuine, suppressed, and faked facial behavior during exacerbation of chronic low back pain. Pain 46: 161-172, 1991
- ~~4823~~. Craig KD, Korol CT: Developmental issues in understanding, assessing, and managing pediatric pain, in Walco G, Goldschneider K (eds.): Pediatric Pain Management in Primary Care: A Practical Guide. Totowa, NJ, The Humana Press Inc, 2008, pp. 9-20
- ~~4924~~. Craig KD, Prkachin KM, Grunau RVE: The facial expression of pain, in Turk DC, R Melzack (eds.): Handbook of Pain Assessment, 2nd ed. New York, NY, Guilford, 2001, pp. 153-169
- ~~2025~~. Craig KD, Stanford EA, Fairbairn NS, Chambers CT: Emergent pain language communication competence in infants and children. Enfance 1: 52-71, 2006
- ~~2426~~. Crombez G, Eccleston C: To express or suppress may be function of others' distress. Behav Brain Sci 25: 457, 2002
- ~~2227~~. de Waal FBM: Putting the altruism back into altruism: The evolution of empathy. Ann Rev Psychol 59: 279-300, 2008
- ~~2328~~. Decety J, Jackson PL: The functional architecture of human empathy. Behav and Cog Neurosci Rev 3: 71-100, 2004
- ~~29~~. Decety J, Michalska KJ, Akitsuki Y: Who caused the pain? An fMRI investigation of empathy and intentionality in children. Neuropsychologia 46: 2607-2614, 2008
- ~~2430~~. Eisenberg N, Strayer J: Evolutionary bases of empathy: Empathy and its development. Cambridge, NY, Cambridge University Press. 1987
- ~~31~~. Ekman, P, Rosenberg E (eds.): What facial expression reveals about emotions, development, psychopathology and health. (Second edition). Oxford, UK, Oxford University Press, 2005

Formatted: French (France)

Formatted: Indent: Left: 0", Hanging: 0.75", Line spacing: Double, Tab stops: 0.25", Left

Formatted: Font color: Auto

Formatted: Font color: Auto

Formatted: Font color: Auto

- ~~2532~~. Fazio RH: On the automatic activation of associated evaluations: An overview. ~~Cognition~~ and Emotion 15: 115-141, 2001
- ~~2633~~. Fazio RH, Hilden LE: Emotional reactions to a seemingly prejudiced response: The role of automatically-activated racial attitudes and motivation to control prejudiced reactions. Person Soc Psychol Bull 27: 538-549, 2001
- ~~2734~~. Feldman Barrett L, Ochsner KN, Gross JJ: Automaticity and emotion. In J. Bargh (Ed.). Social Psychology and the Unconscious New York, NY, Psychology Press, 2007, pp. 173-218
- ~~2835~~. Ford GK, Finn DP: Clinical correlates of stress-induced analgesia: Evidence from pharmacological studies. Pain 140: 3-7, 2008
- ~~2936~~. France CR, France JL, Absi MA, Ring C, McIntyre D: Catastrophizing is related to pain ratings, but not nociceptive flexion reflex threshold. Pain 99: 459-463, 2002
- ~~37~~. Fridlund AJ: Human facial expression: An evolutionary view. San Diego, CA, Academic, 1994
- ~~398~~. Goubert L, Craig KD, Vervoort T, Morley S, Sullivan MJL, Williams A, Cano A, Crombez G: Facing others in pain: the effects of empathy. Pain 118: 286-288, 2005
- ~~3439~~. Goubert L, Craig KD, Buysse A: (2009). Perceiving others in pain: Experimental and clinical evidence on the role of empathy. In W. Ickes W, & J. Decety J (Eds.): The Social Neuroscience of Empathy (pp. 153-165). Massachusetts: The MIT Press, 2009, pp. 153-165
- Goubert L, Craig KD, Buysse A: Perceiving others in pain: Experimental and clinical evidence on the role of empathy. in Ickes W, Decety J (eds.): The Social Neuroscience of Empathy. Cambridge, MA, MIT Press, in press
- ~~3240~~. Goubert, L., Vervoort, T., Cano, A., & Crombez, G. : (2009). Catastrophizing about their children's pain is related to higher parent-child congruency in pain ratings: an experimental investigation. European Journal of Pain, 13, 196-201, 2009

Formatted: Font: 12 pt

Formatted: Line spacing: Double

Formatted: Font: 12 pt, Not Italic

Formatted: Font: 12 pt

Formatted: Font: 12 pt

Formatted: Font: 12 pt

Formatted: Font: 12 pt

Formatted: English (U.S.)

Formatted: English (U.S.)

~~Goubert L, Vervoort T, Cano A, & Crombez G: Catastrophizing about their children's pain is related to higher parent-child congruency in pain ratings: an experimental investigation. European Journal of Pain, in press~~

~~3341. Goubert L, Vervoort T, & Crombez G: (2009). Pain demands attention of others: the approach/avoidance paradox. Pain: 143, 5-6, 2009~~

Formatted: English (U.S.)

Formatted: English (U.S.)

~~Goubert L, Vervoort T, Crombez G: Pain demands attention from others: The approach/avoidance paradox. Pain, in press~~

~~3442. Grunau RV-E, Craig KD: Pain expression in neonates: Facial action and cry. Pain 28: 395-410, 1987~~

~~3543. Hadjistavropoulos T, Craig KD A theoretical framework for understanding self-report and observational measures of pain: A Communications Model. Behav Res Ther 40: 551-570, 2002~~

Formatted: English (U.S.)

~~3644. Hadjistavropoulos HD, Craig KD, Hadjistavropoulos T, Poole GD: Subjective judgments of deception in pain expression: Accuracy and errors. Pain, 65: 247-254, 1996~~

~~3745. Hadjistavropoulos T, Craig KD: Social influences and the communication of pain. in Hadjistavropoulos T, Craig KD (eds.): Pain: Psychological Perspectives. New York, NY: Lawrence Erlbaum, 2004, pp 87-112~~

Formatted: English (U.S.)

~~3846. Hadjistavropoulos T, von Baeyer C, Craig KD: Pain assessment in persons with limited ability to communicate. in Turk DC, Melzack R (eds.): Handbook of Pain Assessment, 2nd Ed. New York, NY. Guilford, 2001, pp. 134-149~~

~~3947. Heider F: The Psychology of Interpersonal Relations. New York, NY, John Wiley & Sons, 1958~~

~~4048. Hill ML, Craig KD: Detecting deception in pain expressions: The structure of genuine and deceptive facial displays. Pain 98: 135-144, 2002~~

~~4149. Hill ML, Craig KD: Detecting deception in facial expressions of pain: Accuracy and training. Clin J Pain 20: 415-422, 2004~~

- ~~42~~50. Jackson PL, Meltzoff AN, Decety J: How do we perceive the pain of others? A window into the neural processes involved in empathy. *NeuroImage* 24: 771-779, 2005
- ~~43~~51. Jensen MP, Karoly P: Self-report scales and procedures for assessing pain in adults. In Turk DC, ~~R~~-Melzack R (eds): *Handbook of Pain Assessment*. New York, NY, Guilford. 2001, pp. 15-34
- ~~44~~52. Jurado MB, Rosselli J: The elusive nature of executive functions: A review of our current understanding. *Neuropsychol Rev* 17: 213-233, 2007
- ~~45~~53. Keefe FJ, Williams DA, Smith SJ: Assessment of pain behaviours. in Turk DC, R Melzack (eds.): *Handbook of Pain Assessment*. New York, NY, Guilford. 2001, pp. 170-187
- ~~54~~64. Kleck RE, Vaughan RC, Cartwright-Smith J, Burns J, Vaughan KB, Colby CA, Lanzetta JT: Effects of being observed on expressive, subjective, and physiological responses to painful stimuli. *J Pers Soc Psychol*, 34: 1211-1218, 1976
- ~~47~~55. Kunz, M., Mylius, V., Schepelmann, K., & Lautenbacher, S.: ~~(2004)~~. On the relationship between self-report and facial expression of pain. *J Pain*, 5, 368-376, 2004
- ~~48~~
- ~~56~~. Labus JS, Keefe, FJ, Jensen MP: Self-reports of pain intensity and direct observations of pain behaviour: when are they correlated? *Pain* 102: 109-124, 2003
- ~~49~~57. Lamm C, Batson CD, Decety J: The neural substrate of human empathy: effects of perspective-taking and cognitive appraisal. *J Cog Neurosci* 19: 42-58. 2007
- ~~59~~58. Larochette AC, Chambers CT, Craig KD: Genuine, suppressed and faked facial expressions of pain in children. *Pain* 126: 64-71, 2006
- ~~54~~59. Malle BF: How people explain behaviour: A new theoretical framework. *Pers Soc Psychol Rev* 3: 23-48, 1999
- ~~52~~60. Malle BF: Three puzzles of mindreading, in Malle BF, Hodges SD (eds): *Other Minds: How Humans Bridge the Divide between Self and Others.*. New York, NY, Guilford Press. 2007, pp. 26-43

61. Marquie L, Raufaste E, Lauque D, Marine C, Ecoiffier M, Sorum P: Pain ratings by patients and physicians: Evidence of systematic pain miscalibration. *Pain* 102: 289-296, 2003
5362. Moors A, ~~De-De~~ Houwer J: Automaticity: A theoretical and conceptual analysis. *Psychological Bulletin* 132: 297-326, 2006
5463. Ochsner KN, Zaki J, Hanelin J, Lodlow DH, Knierim K, Ramachandran T, Glover GH, Mackey SC: Your pain or mine? Common and distinct neural systems supporting the perception of pain in self and other. *Soc Cog Affect Neurosci* 3: 144-160, 2008
5564. Ohman A, Mineka S: Fears, phobias and preparedness: Toward an evolved module of fear and fear learning. *Psychol Rev* 108: 483-522, 2001—
5665. Pillai Riddell RR Craig KD: Judgments of infant pain: The impact of caregiver identity and infant age. *J Ped Psychol* 32: 501-511, 2007
5766. Pinker S: *The Stuff of Thought: Language as a Window into Human Nature*. London UK, Penguin, 2007
5867. Poole GD, Craig KD: Judgments of genuine, suppressed and faked facial expressions of pain. *J Pers Socl Psychol* 63: 797-805, 1992
5968. Prkachin KM, Craig KD: Expressing pain: The communication and interpretation of facial pain signals. *J Nonverb Behav* 19: 191-205, 1995
6069. Prkachin KM Craig KD: Influencing non-verbal expressions of pain: Signal detection analyses. *Pain* 21: 399-409, 1985
6470. Prkachin KM, Solomon PE Ross J: Underestimation of pain by health care providers: Towards a model of the process of inferring pain in others. *Can J Nurs Res* 39: 88-106, 2007
6271. Prochazka A, Clarac F, Loeb GE, Rothwell JC, & Wolpaw JR: What do *reflex* and *voluntary* mean? Modern views on an ancient debate. *Exp Brain Res* 130: 417-432, 2000
6372. Schneider W, Chein JM: Controlled & automatic processing: behaviour, theory, and biological mechanisms. *Cog Sci* 27: 525-559, 2003

~~64~~73. Simon D, Craig KD, Miltner WHR, Rainville P: Brain responses to dynamic facial expressions of pain. *Pain* 126: 309-318, 2006

~~65~~74. Simon D, Craig KD, Gosselin F, Belin P, Rainville P: Recognition and discrimination of prototypical dynamic expressions of pain and emotions. *Pain* 135: 55-64, 2008

~~66~~75. Singer T, Seymour B, O'Doherty JP, Stephan KE, Dolan RJ, Frith CD: Empathic neural responses are modulated by the perceived fairness of others. *Nature* 439(7075): 466-469, 2006

~~67~~76. Singer T, Seymour B, O'Doherty J, Kaube H, Dolan R, Frith CD: Empathy for pain involves the affective but not sensory components of pain. *Science* 303: 1157-1162, 2004

~~68~~77. Smith ER, DeCoster J: Dual-process models in social and cognitive psychology: Conceptual integration and links to underlying memory systems. *Pers Soc Psychol Rev* 4: 108-131, 2000

~~69~~78. Stinson JN, Kavanagh T, Yamada J, Gill N, Stevens BJ: Systematic review of the psychometric properties, interpretability and feasibility of self-report pain measures for use in clinical trials in children and adolescents. *Pain* 125: 143-157, 2006

~~79~~. Stuss DT, Alexander MP: Executive functions and the frontal lobes: a conceptual review. Psychol Res 63: 289-298, 2000

~~79~~80. Sullivan MJL: Toward a biopsychomotor conceptualization of pain. *Clin J Pain* 24: 281-290, 2008

~~74~~81. Sullivan MJL, Adams H, Sullivan ME: Communicative dimensions of pain catastrophizing: Social cueing effects on pain behaviour and coping. *Pain* 107: 220-226, 2004

~~82~~. Tait RC, Chibnall JT, Kalauokalani D: Provider judgments of patients in pain: Seeking symptom certainty. Pain Med 10: 11-34, 2009

~~72~~83. Turk DC, Melzack R (eds): *Handbook of Pain Assessment*, 2nd ed. New York, NY, Guilford, 2001

Field Code Changed

Formatted: Indent: Left: 0", Hanging: 0.5",
Line spacing: Double

Formatted: Font: 12 pt

Formatted: Font: 12 pt

Formatted: Font: 12 pt

Formatted: Indent: Left: 0", Hanging: 0.5",
Line spacing: Double

Formatted: Font: 12 pt

- ~~7384~~. Vancleef LMG, Peters ML, Gilissen SMP, De Jong PJU: Understanding the role of injury/illness sensitivity and anxiety sensitivity in (automatic) pain processing: An examination using the extrinsic affective Simon Task. *J Pain* 8: 563-572-~~2007~~
- ~~7485~~. Vervoort T, Goubert L, Eccleston C, Verhoeven K, De Clercq A, & Buysse A, & Crombez G: The effects of parental presence upon the facial expression of pain: the moderating role of child pain catastrophizing. *Pain* 138: 277-285, 2008
- ~~7586~~. Vervoort T, Goubert L, Crombez G: The relationship between high catastrophizing children's facial display of pain and parental judgment of their child's pain. *Pain* ~~142: 142-148, 2009~~ ~~doi: 10.1016.2008.12.028. 2009~~
- ~~87~~. Vogel G: The evolution of the golden rule. *Science* ~~303: 1128-1131, 2004~~
- ~~7688~~. Wall PD: Pain: The science of suffering. Weidenfeld and Nicolson, 1999
- ~~7789~~. Werner A, Malerud K: It is hard work behaving as a credible patient: encounters between women with chronic pain and their doctors. *Social Science and Medicine* 57: 1409-1419, 2003
- ~~7890~~. Williams ACdeC: Facial expression of pain: an evolutionary account. *Behav Brain Sci* 25: 439-488, 2002
- ~~7991~~. Williams ACdeC, Craig KD: A science of pain expression? *Pain* 125: 202-203, 2006
- ~~8092~~. Yamada M, Decety J: Unconscious affective processing and empathy: An investigation of subliminal priming on the detection of painful facial expressions. *Pain* ~~2009:143:71-75,~~ ~~2009~~ Yamada M, Decety J: Unconscious affective processing and empathy: An investigation of subliminal priming on the detection of painful facial expressions. *Pain in press*

Formatted: Font: Not Italic, English (U.S.)

Formatted: Line spacing: Double

Formatted: English (U.S.)

Formatted: Font: Not Italic, English (U.S.)

Formatted: English (U.S.)

Kenneth D. Craig

Figure 1. A representation of the probable reactions of observers to automatic and expressive displays of people in pain. Automatic expression is likely to instigate automatic, emotional reactions, as well as parallel cognitive appraisal. Controlled expression is less likely to evoke powerful automatic/emotional reactions in observers, but will instigate reflection and interest in various sources of the expression.

Dear Dr. Gebhart:

Thank you for the opportunity to submit a revision of our manuscript "Perceiving pain in others: Automatic and controlled mechanisms". We very much appreciated the recommendations and observations of the reviewers and have revised the paper in accordance with all the suggestions, excepting two observations. We have detailed the various changes in the following, including explanations for deciding to not follow through on two suggestions (see comments on Reviewer #2 observations below).

Your editorial decision letter:

"References 31, 32, 33 and 80 are listed as "in press." If possible, these should be updated with publication information."

These papers have all been published and complete publication information is now provided.

Reviewer #1:

- 1) "Accessibility to average reader--The manuscript contains a fair amount of psychological terminology which may not be familiar to the average reader of the journal. This is unfortunate since it reduces its potential impact on the field. The authors should consider attempting to reframe some of the terminology to deal with this problem."

We have carefully reviewed the paper for jargon not that accessible to others and attempted to make the text clearer. Words or expressions such as the following were removed or explained in clearer language: isomorphic, cognizant, heuristic, prosodic, deploying propositional knowledge, personal agency, instantiating.

- 2) "Citations--Many of the assertions made do not carry citations with them. It would be good to increase the number of citations for readers who wish to examine the evidence underpinning these assertions."

Again we reviewed the paper in an effort to establish where we had failed to provide adequate citations. The following 12 papers have now been referenced in addition to the 80 in the original paper. We could add more, but believe the additional references would be redundant to those provided.

Vogel, G. (2004). The evolution of the golden rule. *Science*, 303, 1128-1131.

Tait RC, Chibnall JT, Kalauokalani D: Provider judgments of patients in pain: Seeking symptom certainty. *Pain Medicine* 10: 11-34, 2009

Marquie L, Raufaste E, Lauque D, Marine C, Ecoiffier M, Sorum P: Pain ratings by patients and physicians: Evidence of systematic pain miscalibration. *Pain* 102: 289-296, 2003

- Bennett-Branson, S.M., & Craig, K.D. (1993). Postoperative pain in children: Developmental and family influences on spontaneous coping strategies. *Canadian Journal of Behavioural Science*, 25, 355-383.
- Chou R, Fu R, Carrion JA, Deyo RA: Imaging strategies for low-back pain: Systematic review and meta-analysis. *Lancet* 373: 463-472, 2009.
- Ekman, P, Rosenberg E (eds.): *What facial expression reveals about emotions, development, psychopathology and health*. (Second edition). Oxford, UK,: Oxford University Press, 2005
- Decety J, Michalska KJ, Akitsuki Y: Who caused the pain? An fMRI investigation of empathy and intentionality in children. *Neuropsychologia* 46: 2607-2614, 2008
- Stuss DT, Alexander MP: Executive functions and the frontal lobes: a conceptual review. *Psychol. Res.* 63: 289-298. 2000
- Fridlund, A.J. (1994). *Human facial expression: An evolutionary view*. San Diego, CA: Academic.
- Cowley AW, Cowley T, Norton NJ, Norton WF: Foreword, in Mayer EA, Bushnell MC (eds.): *Functional pain syndromes: Presentation and pathophysiology*. Seattle, WA, IASP Press, 2009, pp. xiii
- Craig, K.D. & Badali, M.A. (2004). Introduction to the Special Series on the Detection of Pain Deception and Malingering. *Clinical Journal of Pain*, 20, 377-382.
- Cosmides L, Tooby J: Cognitive adaptations for social exchange. in Barkow JH, Cosmides L, Tooby J (eds.): *The Adapted Mind: Evolutionary psychology and the generation of culture*. New York NY, Oxford University Press, 1992, 163-228
- 3) "Page 10--Consider giving more detailed examples of the range of cognitive and affective processes involved in decision making. This would help readers much better understand the potential influence of memory, problem solving, judgement, heuristics, and biases."

This component of the paper addresses the nature of the "Controlled Processes" instigated by viewing others in pain. We have contrasted automatic and controlled processes in several places in the paper. In this section we revised the statement to the following in the interests of clarifying observer processing that is more effortful in the interests of making sense of the suffering person's painful distress:

"When an observer attends to another person's plight, automatic reactions would be accompanied by efforts to understand and plan actions suitable to the situation⁷⁷. There is a need to know not only what is happening to the individual but also why this is happening, what sequence of events led to the person's painful distress, and

what the person could do, or what the observer could do to resolve the situation. Problem-solving, memory, judgment, attitudes and biases are likely to be implicated."

- 4) "Page 11--Explain what is meant by the term "personal agency" in the sentence that ends: "controlled reactions indicative of personal agency". Readers may not understand this. Also, describe what is meant by "default mode" in the next paragraph."

The term personal agency clearly is psychology jargon. We replaced it by "planned goal-directed behavior". The sentence "This is the default mode." is redundant, hence deleted.

- 5) Page 12--Emotional drama--I think many investigators in this area would object to the sentence "Patients often work hard to make the objective/rational assessments less an intellectual experience and more an emotional drama." When one thinks of the large number of people who experience and report on their pain, this statement seems like an over-simplification. It does not seem to adequately capture the research literature in this area. I would recommend dropping this sentence or qualifying it more.

We agree with the reviewer and have replaced the sentence with "Patients often work hard to present convincing cases of the gravity of their condition⁸⁹."

Reviewer #2:

- 1 "It would be helpful to have some brief elaboration of how Moors & de Houwer distinguish automatic and controlled processing, rather than only the reference, to help readers."

Good observation and readily, briefly accomplished. We added Moors and de Houwer's criteria for automatic processing as per the following sentence:

"Criteria for automatic actions, as defined by Moors & De Houwer⁶² include processing at a relatively non-conscious level, efficiency in terms of not requiring effortful processing, absence of a formulated goal, and being purely stimulus driven."

- 2 I'd have liked to see comments on hypotheses around in the field at present, particularly those informing empirical work, such as that simulated pain expression is as good as controlled pain expression for studying observers' reactions (Rainville and others); that pain behaviour, including facial expression can be divided into protective and communicative behaviours (Sullivan and colleagues), or is this distinction not in the behaviours but in their interpretation by observers; or that there might be priority processing for apparently inauthentic expression by a cheater detection algorithm (Williams and colleagues).

Concerning the first point, we have published a number of studies examining the proposition that "simulated pain expression is as good as controlled pain expression for studying observers' reactions (Rainville and others)". In brief summary, people do well in

simulating pain expression (Poole, G.D., & Craig, K.D. (1992). Judgments of genuine, suppressed and faked facial expressions of pain. *Journal of Personality and Social Psychology: Interpersonal Relations and Group Processes*, 63, 797-805.), but there are subtle differences (Craig, K. D., Hyde, S. A., & Patrick, C. J. (1991). Genuine, suppressed, and faked facial behavior during exacerbation of chronic low back pain. *Pain*, 46, 161-172. Hill, M.L., & Craig, K.D. (2002). Detecting deception in pain expressions: The structure of genuine and deceptive facial displays. *Pain*, 98, 135-144.) that are discernible to observers (Hadjistavropoulos, H.D., Craig, K.D., Hadjistavropoulos, T., & Poole, G.D. (1996). Subjective judgments of deception in pain expression: Accuracy and errors. *Pain*, 65, 247-254.). Observers can be taught to distinguish simulated displays with difficulty and not all that successfully (Hill, M.L., & Craig, K.D. (2004). Detecting deception in facial expressions of pain: Accuracy and training. *Clinical Journal of Pain*, 20, 415-422.). Skill in dissimulating pain appears acquired, as children do not do as well as adults (Larochette, A.C, Chambers, C.T., & Craig, K.D. (2006). Genuine, suppressed and faked facial expressions of pain in children. *Pain*, 126, 64-71.). We have addressed the complexities of detecting simulation in several review chapters, e.g., Craig, K.D., Hill, M.L., McMurtry, B. (1999). Detecting deception and alingering. In A.R. Block, E.F. Kramer, & E. Fernandez (Eds.), *Handbook of Chronic Pain Syndromes: Biopsychosocial Perspectives*. pp. 41-58. New York: Lawrence Erlbaum. Our work with Pierre Rainville (Simon, D., Craig, K.D., Gosselin, F., Belin, P., & Rainville, P. (2008). Recognition and discrimination of prototypical dynamic expressions of pain and emotions. *Pain*, 135, 55-64. Simon, D., Craig, K.D., Miltner, W.H.R., & Rainville, P. (2006). Brain responses to dynamic facial expressions of pain. *Pain*, 126, 309-318.) using actors trained to simulate pain and a range of emotional displays was complicated by the findings we and others have generated indicating that there are subtle differences between genuine and dissimulated displays and we used a number of training strategies and validity checks to overcome the problem. We did not address the issues in detail in the paper submitted, but the basic substance of the issues was described, for example, "Control can be achieved over facial displays of pain²², including both exaggeration and suppression of the display; however, the exaggerated display differs from the genuine display in subtle ways⁵², and neither faking nor suppression of facial displays are wholly successful^{44, 67}."

The second point ("that pain behaviour, including facial expression can be divided into protective and communicative behaviours (Sullivan and colleagues), or is this distinction not in the behaviours but in their interpretation by observers") was addressed in the paper. For example, the primary paragraph addressing this begins with "In considering types of automatic behaviour it is useful to distinguish between observable actions that are directly protective, because they permit escape or avoidance of sources of pain, and those that are indirectly protective because they communicate distress to others, thereby eliciting their protective interventions⁸⁰" We could provide many additional references, including those to our own work using the distinction, but reference

80 effectively covers the field and includes many additional references that demonstrate the validity of the distinction. We would argue that the distinction can be made independent of the judgment of the observer.

The third point ("that there might be priority processing for apparently inauthentic expression by a cheater detection algorithm (Williams and colleagues") lies at the heart of much evolutionary biology/psychology theorizing and study in discussion of such topics as reciprocal altruism and psychopathic behavior. We acknowledge the point in adding the following statement "Universal propensities to detect cheaters have been postulated by evolutionary biologists to account for careful scrutiny of others in social^{13,20,48,49,90}", but hesitate to provide a more complete analysis. Papers referenced do provide the extensive analysis.

Final observations, following, have been addressed:

On p 9 I don't understand the sentence: Automatic processing can be (Bottom up or stimulus driven processes). What is meant by the brackets and underlining?

Reference 7 I think should be to Neuroimage, not NeroImage!
And reference 15 has an odd format for the date.

There are additional minor wording changes that improve the writing.

Thank you for the opportunity to revise and resubmit.

Sincerely,
Ken

Kenneth D. Craig,
Professor of Psychology